THE RESPONSE OF THREE OILSEED BRASSICA SPECIES TO DIFFERENT PLANTING DATES AND SEED RATES IN HIGHLAND ETHIOPIA

Hiruy Belayneh, K.W. Riley, Negatu Tadesse and Getinet Alemaw - Ethiopian Highland Oilcrops Improvement Team, Box 2003, Addis Ababa, Ethiopia.

Abstract

Brassica carinata is grown traditionally by Ethiopian farmers as both an oilseed and a vegetable crop, while B. campestris and B. napus were introduced about 10 years ago into Ethiopia. The performance of a B. carinata (S-67), a B. napus (Target), and a B. campestris (Torch) cultivar was evaluated at a number of locations in Ethiopia above 2000 m elevation.

Seed yield of S-67 approached 3500 kg/ha under ideal conditions, where the grain filling period was prolonged. At sites where maturity was accelerated yields of S-67 and Target were similar. Yields of Torch were low at all sites. Highest yields for all cultivars were obtained when planted at the onset of the main rains, expected in mid-June at most sites. A seed rate from 6-10 kg/ha was found to be optimal, depending on the season and location. Mean oil content of Target was 45%, while both S-67 and Torch averaged 40% at Holetta in 1981. Mean 1000 seed weight of S-67 was equal to, or slightly greater than that of Target, and much greater than that of Torch.

Cultivars of both B. carinata and B. napus can produce good yields in highland Ethiopia, but under long growing season conditions, B. carinata may have an advantage. Experimental lines of B. carinata which are earlier and have oil contents equal to those of B. napus have been identified and are now being tested.

Introduction

Ethiopia, with its range of altitudes and soil types, provides conditions suitable for cultivation of a diversity of oil crops. Ethiopian mustard (Brassica carinata) locally known as gomenzer, is important as a source of oil and a leafy vegetable in mid altitude and highland areas, from 1650 to 2600 meters above sea level. The crop is grown mainly by small farmers in more fertile, well-drained areas, often close to their houses.

B. carinata is thought to have arisen from the hybridization of B. oleracea and B. nigra (Hemingway 1976). Both parental species are found as crops in the same areas where B. carinata is grown. B. nigra, locally known a Senafitch, is used as a spice, and B. oleracea known as Wollammo or Gurage gomen, is used as a leafy vegetable. Over 600 local collections of the three Brassica species have been made. Evaluation of these materials has led to the release of 5 B. carinata varieties; one of these is named S-67. These released varieties have been reported to produce grain yields up to 4800 kg/ha and possess oil contents from 31 to 46% under experimental conditions (Chevreau, 1974). Erucic acid levels in the oil are high (30-47%) (Wesphal 1973). High levels of glucosinolates, primarily allyl isothiocyanate have been found in B. carinata (Klassen, 1973. Personal communication to F. Pinto).

B. napus and B. campestris were introduced into Ethiopia about 10 years ago from Europe and Canada. Target is the only released B. napus variety in the country, and is grown on mechanized farms. Promising introductions with low erucic acid and low glucosinolate levels with yields of 3000 kg/ha and oil content of 48% have been identified. At present, there are no released varieties of B. campestris, but the variety called Torch shows promise in low rainfall areas.

Preliminary agronomic investigations have been carried out on B. napus and B. carinata in Ethiopia (Chevreau, 1974). It was recommended that B. carinata varieties be planted with the onset of the main rains to achieve maximum

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yields. A seed rate of 10 kg/ha for both B. carinata and B. napus was found to produce highest yields in the highlands of Ethiopia. In Western Canada, an early planting date was found to produce highest yields of B. napus (Midas) while highest yields of B. campestris (Torch) were found with an intermediate planting date (Kondra, 1977b). Mustard/rapeseed yields were reported highest with early planting, and declined with late plantings (Degenhardt and Kondra 1981b). Planting date did not affect the 1000 seed weight of B. napus (Degenhardt and Kondra, 1981a). A range of seeding rates from 2 to 15 kg/ha were suggested by Loof (1972) for oilseed brassicas. In Western Canada, a seed rate of 6 kg/ha gave the best yields of B. napus and B. campestris. Seed rate had no significant effect on 1000 seed weight (Kondra, 1977a).

This study was undertaken to assess the responses of cultivars representing 3 Brassica species to different planting dates and seed rates under a range of environments in Highland Ethiopia.

Materials and Methods

The study was conducted for two growing seasons (1981 and 1982) at Holetta and Kulumsa and one growing season (1982) at Robe. Robe, Holetta and Kulumsa are at an altitude of 2480, 2400 and 2200 meters and latitude of about 7°,9° and 8° north respectively. The trials at Holetta were planted on a red-brown clay loam soil, at Kulumsa on a dark grey alluvial soil, and at Robe on a dark vertisol. Daily maximum and minimum air temperatures and rainfall for the growing seasons were recorded at the sites each year and the ten day averages are given in Figure 1.

Three Brassica species viz B. carinata (S-67) B. napus (Target) and B. campestris (Torch) were planted on four dates (Starting with expected onset of steady rains) using four seeding rates (6,8,10 and 12 kg/ha). At Robe, a bimodal rainfall pattern is normal, and planting started with the expected onset of the second rains. Treatments were arranged in three replications of a split-split plot design with planting date as main plot, cultivars as sub-plot and seeding rate as sub-sub plot. Location was superimposed as a fixed effect factor, with main plot error used for testing locations, planting dates and their interaction. Plot size was 9m² with 6 rows per entry spaced at 30 cm and 5 m in length. The center four rows were used for date collection and yield determination. The cultivars were hand planted. Fertilizer was applied on each plot at planting at the rate of 46/69 kg/ha of N and P_2O_5. Seed oil percentage was determined by solvent extraction method using Ra-Fa-Tec oil extractor, manufactured by Tecator.

Significant interactions for grain yield are illustrated by graph, with selected interactions illustrated for other plant characters.

Results and Discussion

Grain Yields

Location Effects - Mean location yields (Figure 2A,B,C) ranged from 1517 kg/ha at Kulumsa in 1981, to 2845 kg/ha at Robe in 1982. Yields at Holetta declined from 1981 to 1982, but increased at Kulumsa during the same period. At all locations, yields declined when planting was delayed more than 10 days after the start of the main rains. The main rains, as shown in Figure 1, started with planting date 3 in 1981, and with planting date 1 in 1982 at both Holetta and Kulumsa, and with planting date 2 in 1982 at Robe. Planting carried out before the start of the main rains did not result in any significand reduction in yield at these sites.

Species Effect (Figure 2B,D) - The B. carinata entry (S-67) produced the highest mean grain yield of 2840 kg/ha, followed by 2266 kg/ha for the B. napus (Target) and 984 kg/ha for the B. campestris (Torch)entries. At one location (Holetta 1982) the yield of Target was significantly higher than that of S-67.

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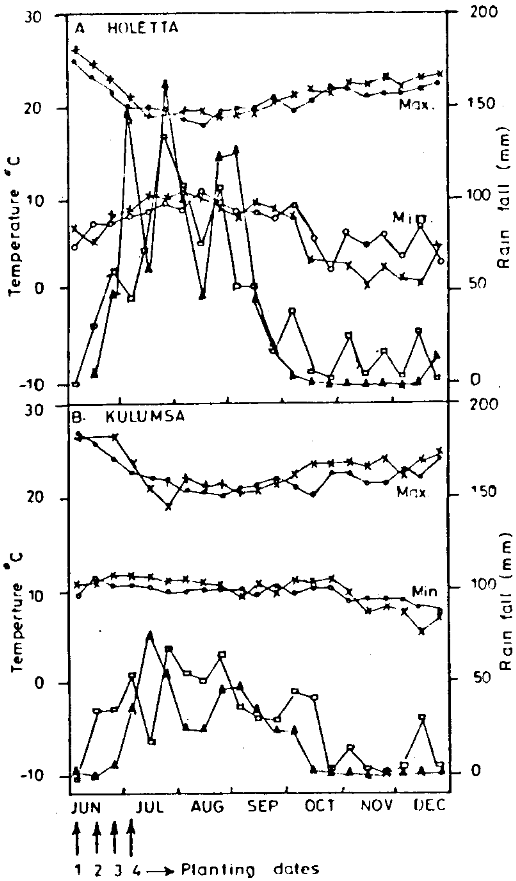

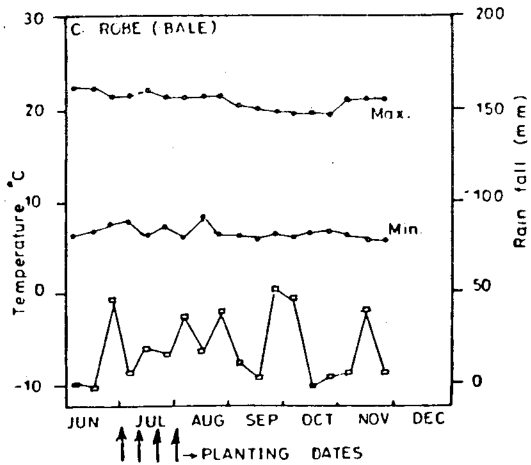

FIG 1. Ten day mean of maximum and minimum temperatures (x—x 1981 •—• 1982) and rain fall (▲—▲ 1981 □—□ 1982) measured at the three experimental sites (HOLETTA, KULUMSA, and ROBE)

	Total seasonal Rain fall (mm)	Average seasonal temperature Maximum	Minimum
HOLETTA 81	897.7	21.3	6.3
HOLETTA 82	873.1	20.8	7.0
KULUMSA 81	409.9	22.9	9.7
KULUMSA 82	614.7	22.3	9.7
ROBE 82	[illegible]	21.0	6.7

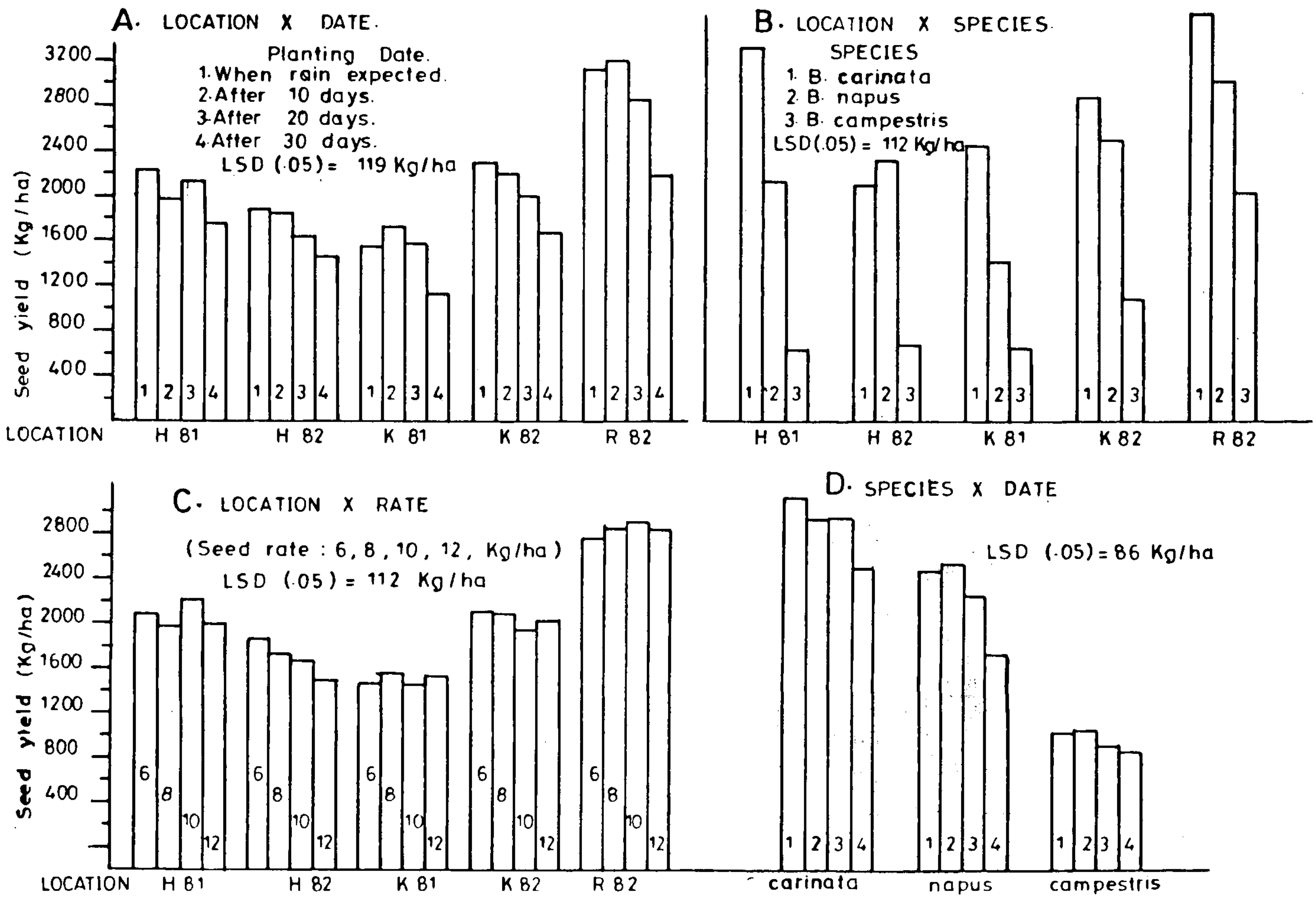

FIGURE 2 INTERACTIONS BETWEEN LOCATIONS, PLANTING DATES, AND SEED RATES ON GRAIN YIELD OF THREE BRASSICA SPECIES. LOCATIONS: H = HOLETTA, K = KULUMSA, R = ROBE

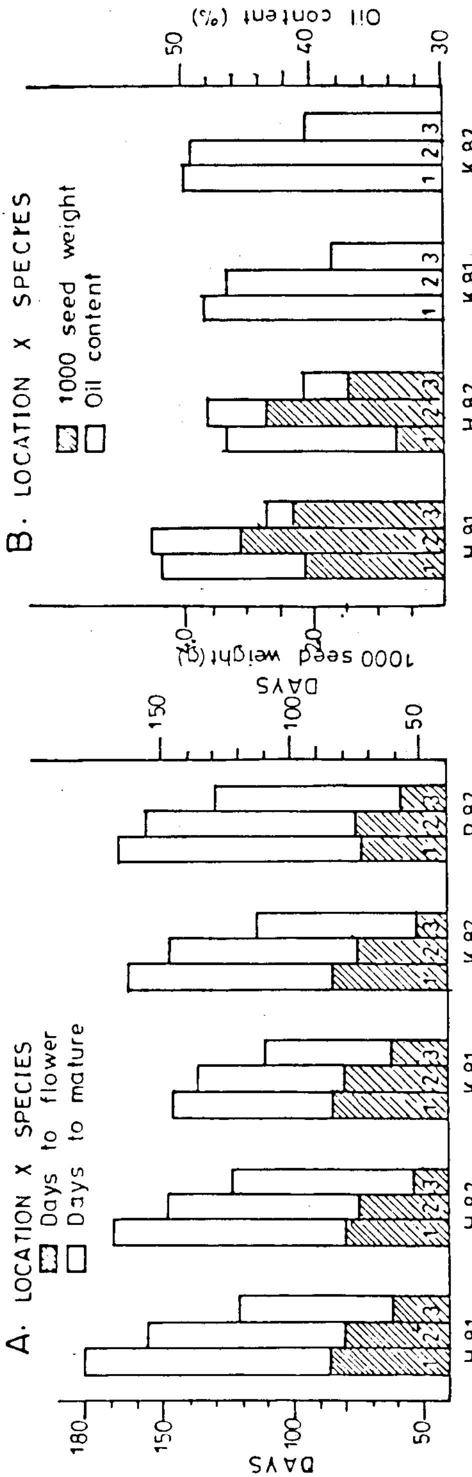

FIGURE 3 INTERACTION BETWEEN LOCATION AND SPECIES FOR (A) DAYS TO FLOWER AND MATURE, AND (B) 1000 SEED WEIGHTS (G) AND OIL CONTENTS (%). CODES AS DESCRIBED IN FIGURE 2. LSD (.05) FOR DAYS TO FLOWER = 3.0; DAYS TO MATURE = 6.9; 1000 SEED WEIGHT = 0.39G; OIL CONTENT = 1.62%

Location x Seed rate (Figure 2C)
Mean yields were not significantly affected by seeding rates from 6 to 10 kg/ha, but declined slightly with the 12 kg/ha rate. At Holetta in 1982, where stress was encountered, the lowest rate (6 kg/ha) resulted in the highest yield, whereas the 10 kg/ha rate had a slight advantage at the two top yielding locations (Holetta 1981 and Robe 1982).

Species x Planting date (Figure 2D)
Planting date 1 produced highest yields of S-67, while maximum yields of Target and Torch were recorded for either planting date 1 or 2. Later plantings resulted in much greater yield reduction of Target and S-67 than of Torch, but S-67 and Target maintained their yield superiority at all planting dates.

Days to Flower and Maturity

The location x species interaction is illustrated in Figure 3A. S-67, the highest yielding entry, was also the slowest to flower and mature. Mean days to flower and mature were 82 and 164 for S-67, 77 and 149 for Target, and 57 and 122 for Torch. The lower yielding locations were those with shorter grain filling and maturity periods. The highest yielding location (Robe 1982) flowered most rapidly and had the longest grain filling period. This location had lower minimum temperatures during early growth than other locations, which may have resulted in the longer grain filling period.

Thousand Seed Weight and Oil Content (Figure 3B)

From 4 locations, the 1000 seed weight mean of S-67 (3.85 g) was equal to that of Target (3.81g) and much greater than Torch (2.1g). Lower yielding locations produced the lowest 1000 seed weights. Other effects were not found to be significant.

Oil contents from 2 locations (Holetta 1981 and 1982) averaged 38% for S-67, 44% for Target and 39% for Torch. During 1982, oil contents of all cultivars were reduced, with S-67 dropping from 40.5% in 1981 down to 33.5% in 1982.

Other Plant Characters

Plant height averaged 185 cm for S-67, 159 cm for Target and 133 cm for Torch. No other effects were significant. Lodging was a problem at only one location (Kulumsa 1982), where Target lodged more severely than the other two cultivars.

Seed shattering was more severe at Holetta in 1982 (6%) than in 1981 (3%). S-67 had least shattering (3%) followed by Target (4%), while Torch was most prone to shattering (6%).

Alternaria brassicae, which produces pod and leaf spot, is the most serious disease of oilseed brassicas in Ethiopia. Holetta in 1982, had the highest leaf spot incidence. Levels on Torch were much higher than on the other two cultivars.

Stagheads, produced by downy mildew and white rust are minor problem. More stagheads were found on S-67 and Target than on Torch. In Canada, *B. campestris* is susceptible but *B. napus* is reported immune to prevelent races of white rust (Burgess *et al*, 1979).

It would appear that the generally high yields recorded for S-67 and Target at most locations is due to their ability to make use of the long growing season found at many locations in the highlands of Ethiopia. Torch with its faster growth cycle, could not compete, even when planting was delayed. At Holetta in 1982 and Kulumsa in 1981, yields did not reach their maximum potential which was reflected in faster maturity, reduced grain filling period, lighter seeds, and at Holetta, lower oil contents and increased disease incidence. Climatic differences from one season to the next (Figure 1) help to explain why yields were low at these two locations. Holetta, in 1982 had higher minimum temperatures, and prolonged rainfall at the end of the growing season, which may have encouraged the higher disease incidence especially in the long maturing S-67, while at Kulumsa in 1981, the rainfall was lower than in 1982, especially during stand establishment, flowering and pod formation periods.

B. carinata lines have been identified with oil contents equal to that of *B. napus*, and with earlier maturity for adaptation to areas with a shorter growing season. In addition, an interspecific hybridization program has been started to incorporate genes for low erucic acid and glucosinolate levels into *B. carinata*.

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